



# Glass Life Cycle Analysis Washington Glass Summit

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Glass  
(melted)

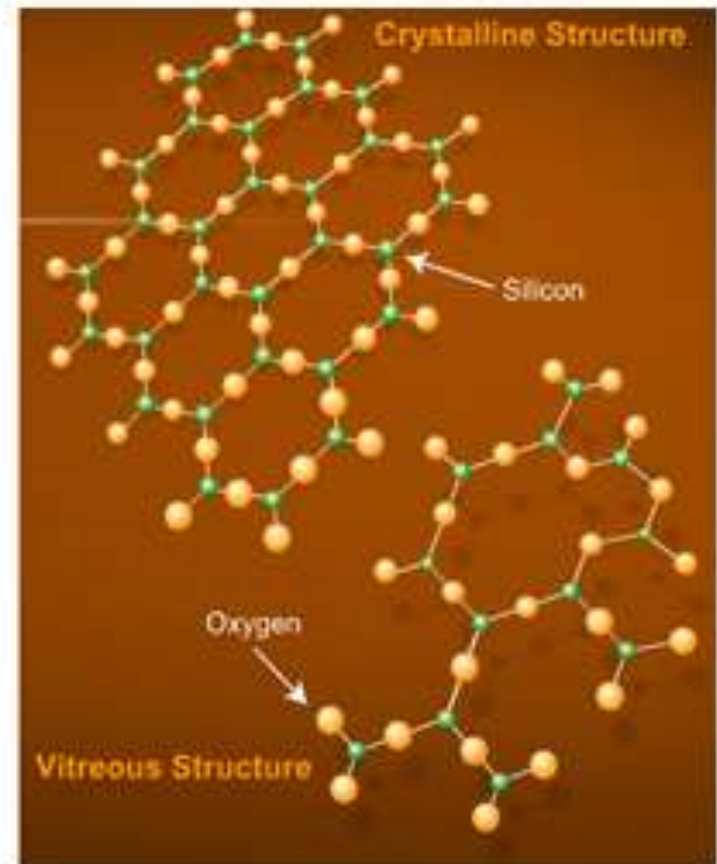


Quartz  
crystals



## What is glass?

An amorphous solid consisting mainly of silicone dioxide and other metal oxides





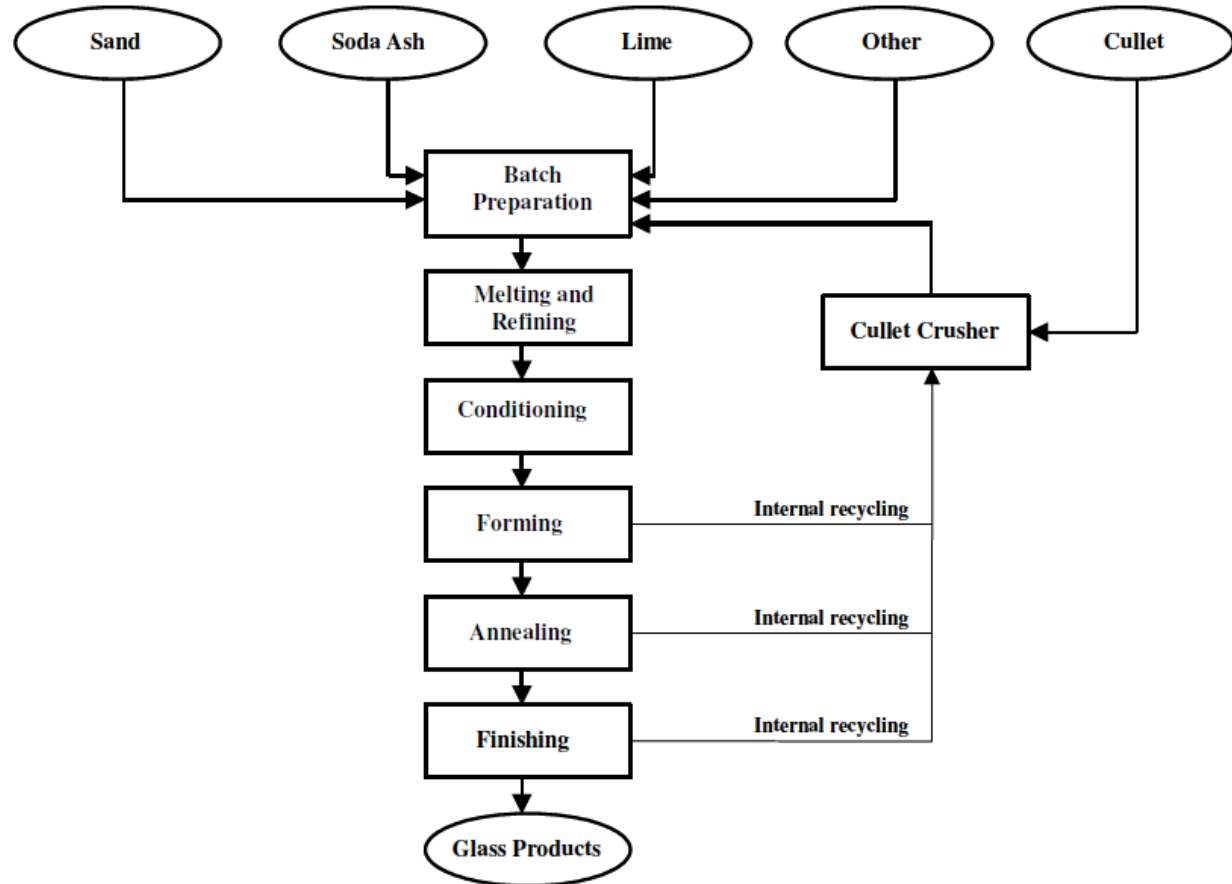
### Approximate composition of different glass types

Oxide	Container Glass	Float glass	Fiberglass (E-Glass)	Laboratory Ware
SiO <sub>2</sub> [w%]	73	72	54	80
B <sub>2</sub> O <sub>3</sub> [w%]			10	10
Al <sub>2</sub> O <sub>3</sub> [w%]	1.5	0.3	14	3
CaO [w%]	10	9	17.5	1
MgO [w%]	0.1	4	4.5	1
Na <sub>2</sub> O [w%]	14	14		5
K <sub>2</sub> O [w%]	0.6			

Source: <http://www.energystar.gov/ia/business/industry/Glass-Guide.pdf> downloaded 11/1/2009



Simplified process schematic of glass manufacture





## Energy Use in Manufacture is Large

- Energy is roughly 14% of glass production cost
- Glass manufacturing uses about 1% of all United States industrial energy



## Glass Production in the United States

Container glass	10 million tons
Flat (window) glass	5 million tons
Fiberglass	3 million tons
Specialty glass (cookware, monitors)	2 million tons
<b>Total</b>	<b>20 million tons</b>



## Energy for 1 ton of Production

(Million BTUs per ton of product)

Product	Energy per ton	Source
Glass from virgin materials	6.49	1
Glass from cullet (recycled glass)	4.32	1
Aggregate (crushing)	0.05	2
Transport by dumptruck 100 miles	0.68	2
Transport by transport truck 100 miles	0.14	3
Transport by rail 100 miles	0.033	3
Transport by ship 100 miles	0.026	3

- 1) "Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks", EPA530-R-02-006, May 2002.
- 2) "Background Document for Life-Cycle Greenhouse Gas Emission Factors for Clay Brick Reuse and Concrete Recycling", EPA530-R-03-017, 11/03, Exhibit B-9
- 3) DEQ Water Bottle Study (soon to be published)

# Focus: Transport to Markets

**Question: When are Markets “Too Far”  
to Justify Long-Haul?**

Material	Production Savings (MMBTU/ton collected)	<u>“Break-Even Point” (miles)</u>		
		Truck	Rail	Freighter
Aluminum	177	121,000	475,000	538,000
LDPE	61	41,000	162,000	184,000
PET	59	40,000	157,000	178,000
Steel	19	13,000	52,000	59,000
Newspaper	16	11,000	43,000	49,000
Corrugated	12	9,000	33,000	38,000
Office Paper	10	7,000	27,000	31,000
Boxboard	6.5	4,400	17,400	19,800
Glass (to bottles)	1.9	1,300	5,100	5,800

# End Markets Matter! (sometimes)

**Cullet to Bottle Recycling (Portland)**  
**Net Energy Savings: ~2.1 MMBTU/ton**



**Cullet to Aggregate  
Recycling (Local)**  
**Net Energy Savings:  
~0.2 MMBTU/ton**

**Cullet to Fiberglass Recycling (California)**  
**Net Energy Savings: ~2.1-3.2 MMBTU/ton**

## Oregon Glass Container Tonnage 2005

Material Name	Disposed	Recycled	Generated	% recycled
Based on EPA per capita				
Beer & soft drink	60,928	26,902	87,830	30.6%
Other container glass	39,308	7,002	46,310	15.1%
Total glass bottles, jars	100,236	33,904	134,140	25.3%
Actual Oregon estimates				
Beer & soft drink	10,063	63,055	73,118	86.2%
Other container glass	31,827	29,149	60,976	47.8%
Total glass bottles, jars	41,810	92,204	134,094	68.8%